

**TOXICOLOGICAL PROFILE FOR
TRICHLOROETHYLENE**

**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry**

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1. PUBLIC HEALTH STATEMENT

This public health statement tells you about trichloroethylene and the effects of exposure.

The Environmental Protection Agency (EPA) has identified 1,428 hazardous waste sites as the most serious in the nation. These sites make up the National Priorities List (NPL) and are targeted for long-term federal clean-up. Trichloroethylene has been found in at least 861 NPL sites. However, it's unknown how many NPL sites have been evaluated for this substance. As EPA looks at more sites, the sites with trichloroethylene may increase. This is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it by breathing, eating, touching, or drinking.

If you are exposed to trichloroethylene, many factors will determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS TRICHLOROETHYLENE?

Trichloroethylene is also known as Triclene and Vitran and by other trade names in industry. It is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and a sweet, burning taste. Trichloroethylene is now mainly used as a solvent to remove grease from metal parts. It is also used as a solvent in other ways and is used to make other chemicals.

Trichloroethylene can also be found in some household products, including typewriter correction fluid, paint removers, adhesives, and spot removers. Most people can begin to smell trichloroethylene in air when there are around 100 parts of trichloroethylene per million parts of air (ppm). Further information on the physical and chemical properties of trichloroethylene can be found in Chapter 3, and further information on its production and use can be found in Chapter 4.

1. PUBLIC HEALTH STATEMENT

1.2 WHAT HAPPENS TO TRICHLOROETHYLENE WHEN IT ENTERS THE ENVIRONMENT?

By far, the biggest source of trichloroethylene in the environment is evaporation from factories that use it to remove grease from metals. It can also enter the air and water when it is disposed of at chemical waste sites. It evaporates easily but can stay in the soil and in groundwater. Once it is in the air, about half will be broken down within a week. When trichloroethylene is broken down in the air, phosgene, a lung irritant, can be formed. Trichloroethylene can break down under high heat and alkaline conditions to form dichloroacetylene and phosgene. In the body, trichloroethylene may break down into dichloroacetic acid (DCA), trichloroacetic acid (TCA), chloral hydrate, and 2-chloroacetaldehyde. These products have been shown to be toxic to animals and are probably toxic to humans. Once trichloroethylene is in water, much will evaporate into the air; again, about half will break down within a week. It will take days to weeks to break down in surface water. In groundwater the breakdown is much slower because of the much slower evaporation rate. Very little trichloroethylene breaks down in the soil, and it can pass through the soil into underground water. It is found in some foods. The trichloroethylene found in foods is believed to come from contamination of the water used in food processing, or from food processing equipment cleaned with trichloroethylene. It does not build up in fish, but low levels have been found in them. It is not likely to build up in your body. For more information on trichloroethylene in the environment, see Chapters 4 and 5.

1.3 HOW MIGHT I BE EXPOSED TO TRICHLOROETHYLENE?

Trichloroethylene is found in the outdoor air at levels far less than 1 ppm. When measured several years ago, some of the water supplies in the United States were found to have trichloroethylene. The most recent monitoring study found average levels in surface water ranging from 0.0001 to 0.001 ppm of water and an average level of 0.007 ppm in groundwater. About 400,000 workers are routinely exposed to trichloroethylene in the United States. The chemical can also get into the air or water in many ways, for example, at waste treatment facilities; by evaporation from paints, glues, and other products; or by release from factories where it is made. Another way you may be exposed is by breathing the air around factories that use the chemical. People living near hazardous waste sites may be exposed to it in the air or in

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The reaction of volatile chlorinated hydrocarbons with hydroxyl radicals is temperature dependent and thus varies with the seasons, although such variation in the atmospheric concentration of trichloroethylene may be minimal because of its brief residence time (EPA 198%). The degradation products of this reaction include phosgene, dichloroacetyl chloride, and formyl chloride (Atkinson 1985; Gay et al. 1976; Kirchner et al. 1990). Reaction of trichloroethylene with ozone in the atmosphere is too slow to be an effective agent in trichloroethylene removal (Atkinson and Carter 1984).

5.3.2.2 Water

Oxidation of trichloroethylene in the aquatic environment does not appear to be a significant fate process, probably because of its having already been oxidized by the chlorine atoms. The rate of hydrolysis is also too slow to be an important transformation process (EPA 1979b). A study by Jensen and Rosenberg (1975) indicated that the rate of volatilization of trichloroethylene proceeds more rapidly than photooxidation or hydrolysis. Studies of photolysis and hydrolysis conducted by Chodola et al. (1989) demonstrated that photolysis did not contribute substantially to the transformation of trichloroethylene. Chemical hydrolysis appeared to occur only at elevated temperature in a high pH environment and, even then, at a very slow rate. Studies of the degradation of trichloroethylene in water during ultraviolet irradiation indicated that degradation decreased with increases in the total organic content of the water (Beltran et al. 1995).

Results from experiments conducted at high pH and temperature were extrapolated to pH 7 and 25°C (Jeffers et al. 1989), and the estimated half-life was 1.3×10^6 years, which suggests that hydrolysis does not occur under normal environmental conditions. In contrast, estimates of the hydrolysis half-life of trichloroethylene under corresponding conditions were cited in other studies as about 10.7 months (Dilling et al. 1975) and 30 months (Pearson and McConnell 1975). It is not clear why there is such a large difference between these values; however, errors inherent in the extrapolation method used in the first approach (Jeffers et al. 1989) and the presence of transformation factors other than-chemical hydrolysis, such as microbial degradation, in the second approach (Dilling et al. 1975; Pearson and McConnell 1975) may account for the discrepancy in the numbers.

5. POTENTIAL FOR HUMAN EXPOSURE

An aerobic degradation study of trichloroethylene in seawater showed that 80% of trichloroethylene was degraded in 8 days (Jensen and Rosenberg 1975). Degradation products were not reported. Another study using domestic waste water as a microbial inoculum found that after the 1st week of incubation, 64% and 38% degradation was achieved for initial trichloroethylene concentrations of 5 and 10 ppm, respectively (Tabak et al. 1981). After the 4th week of incubation, these percentages were 87% and 84%, respectively. Microbial degradation products of trichloroethylene in groundwater were reported to be dichloroethylene and vinyl chloride (Smith and Dragun 1984).

Biotransformation was also strongly indicated as a factor in the degradation of trichloroethylene in a case of soil and groundwater pollution (Milde et al. 1988). The only ethylenes at the point source of pollution were tetrachloroethylene and trichloroethylene; however, substantial amounts of known metabolites of these two compounds (dichloroethylene, vinyl chloride, and ethylene) were found at points far from the source. Data from laboratory studies by the same group supported the study authors' contention that degradation was due to reductive dehalogenation by microorganisms. Microcosm studies of trichloroethylene biotransformation in aquifers have also indicated that reductive dehalogenation is the primary degradation reaction (Parsons et al. 1985; Wilson et al. 1986). However, a field study of groundwater at the Lawrence Livermore National Laboratory found a highly oxidized environment in which no evidence of reductive dehalogenation of trichloroethylene was seen (McNab and Narasimhan 1994).

Since neither biodegradation nor hydrolysis occurs at a rapid rate, most trichloroethylene present in surface waters can be expected to volatilize into the atmosphere. However, because trichloroethylene is denser than and only moderately soluble in water, that which is not immediately volatilized may be expected to submerge and thus be removed from contact with the surface (Doust and Huang 1992).

5.3.2.3 Sediment and Soil

The majority of trichloroethylene present on soil surfaces will volatilize to the atmosphere or leach into the subsurface. Once trichloroethylene leaches into the soil, it appears not to become chemically transformed or undergo covalent bonding with soil components. When trichloroethylene was absorbed onto kaolinite and bentonite, the ¹³C nuclear magnetic resonance (CNMR) spectra showed no evidence of chemical reactions (Jurkiewicz and Maciel 1995). Because trichloroethylene is a dense nonaqueous